

REMARKS

Claims 1, 4, 7-16, 19, 20, 23, 26, 32, 33 and 36-41 are pending and under consideration.

Claims 1, 4, 12, 19, 23 and 33 have been amended. Proper support for the amendments to claims 1, 12, 19 and 33 can be found in the specification at least at Table 1 of the specification. Claims 4 and 23 have been amended to correct the minor informalities noted by the Examiner. Claims 38-41 have been added, proper support for these new claims can be found in the specification at least at Table 1 of the specification. Claims 38-41 are allowable at least because they recite volume ratios of the strong polar solvent to the weak polar solvent to the lithium protection solvent, which are not taught or suggested by any of the references cited in the Office Action.

Claims 1, 12, 19, 33 and 38-41 are the independent claims.

No new matter is believed to have been added. Reconsideration is respectfully requested.

OBJECTIONS

Claims 4 and 23 are objected to because of the following informalities: the Markush group should be closed by "and". Specifically, "and" should be inserted before "heterocyclic compounds". Appropriate correction is required.

Applicants have amended claims 4 and 23 in accordance with the Examiner's comments. Accordingly, Applicants respectfully request that the objections to claims 4 and 23 be withdrawn.

REJECTIONS UNDER 35 U.S.C. §102/103:

Claims 1, 4, 7-16, 19, 20, 23, 26, 32, 33, 36 and 37 are rejected under 35 U.S.C. §102(e)/103(a) as being anticipated by, or alternatively unpatentable over Thibault et al., (U.S. 6,190,426).

Applicants respectfully traverse this rejection for at least the following reason.

Regarding the rejection of independent claim 1, it is noted that claim 1, as amended, recites a lithium sulfur battery comprising, amongst other novel features, a volume ratio of the

weak polar solvent to the strong polar solvent to the lithium protection solvent being 3:1:1.

Thibault discloses a prismatic cell comprising an anode, a cathode and an electrolyte. The anode includes an anode active layer comprising lithium (column 21, lines 61-67), the cathode includes a cathode active layer (column 23, lines 33-35) and the electrolyte includes a variety of electrolyte solvents (column 27, lines 61-35).

Accordingly, although Thibault discloses a cell comprising a cathode, an anode and an electrolyte including a variety of electrolyte solvents, Thibault fails to teach or suggest that it is preferable to include all three types of solvents in the electrolyte, such as a weak polar solvent, a strong polar solvent and a lithium protection solvent, as recited in independent claim 1.

Furthermore, Thibault fails to teach or suggest a lithium sulfur battery comprising, a volume ratio of the weak polar solvent to the strong polar solvent to the lithium protection solvent being 3:1:1, as recited in independent claim 1.

Accordingly, Applicants respectfully assert that the rejection of independent claim 1 under 35 U.S.C. § 102(e)/103(a) should be withdrawn because Thibault fails to teach or suggest each feature of independent claim 1, as amended.

Furthermore, Applicants respectfully assert that dependent claims 4, 7-11 and 36 are allowable at least because of their dependence from claim 1 and because they include additional features which are not taught or suggested by the prior art. Therefore, it is respectfully submitted that claims 4, 7-11 and 36 also distinguish over the prior art.

Regarding the rejection of independent claim 12, it is noted that claim 12 recites a lithium-sulfur battery comprising, amongst other novel features, an electrolyte including a sulfur-containing electrolyte salt and mixed organic solvents, the mixed organic solvents comprising three different solvents, each selected from a different group of a set of groups, the set of groups consisting of a weak polar solvent group, a strong polar solvent group, and a lithium protection solvent group, wherein a volume ratio of the weak polar solvent to the strong polar solvent to the lithium protection solvent is 2:2:1.

As noted above, Thibault discloses a cell comprising a cathode, an anode and an electrolyte which may include a plurality of electrolyte solvents, but fails to teach or suggest that it is preferable to include all three types of solvents in the electrolyte, such as a weak polar

solvent, a strong polar solvent and a lithium protection solvent, as recited in independent claim 12. Furthermore, Thibault fails to teach or suggest any volume ratio of the weak polar solvent to the strong polar solvent to the lithium protection solvent, and in particular that this volume ratio is 2:2:1, as recited in independent claim 12.

Accordingly, Applicants respectfully assert that the rejection of independent claim 12 under 35 U.S.C. § 102(e)/103(a) should be withdrawn because Thibault fails to teach or suggest each feature of independent claim 12, as amended.

Furthermore, Applicants respectfully assert that dependent claims 13-16 and 37 are allowable at least because of their dependence from claim 12 and because they include additional features which are not taught or suggested by the prior art. Therefore, it is respectfully submitted that claims 13-16 and 37 also distinguish over the prior art.

Regarding the rejection of independent claim 19, it is noted that claim 19 recites an electrolyte for use in a lithium-sulfur battery having electrode, the electrolyte comprising, amongst other novel features, a weak polar solvent, a strong polar solvent, and a lithium protection solvent, wherein a volume ratio of the weak polar solvent to the strong polar solvent to the lithium protection solvent is 3:1:1.

As noted above, Thibault discloses a cell comprising a cathode, an anode and an electrolyte including various solvents. However, Thibault fails to teach or suggest that the electrolyte includes all three types of solvents, such as a weak polar solvent, a strong polar solvent and a lithium protection solvent, as recited in independent claim 19.

Furthermore, Thibault fails to teach or suggest any volume ratio of the weak polar solvent to the strong polar solvent to the lithium protection solvent, and in particular that this volume ratio is 3:1:1, as recited in independent claim 19.

Accordingly, Applicants respectfully assert that the rejection of independent claim 19 under 35 U.S.C. § 102(e)/103(a) should be withdrawn because Thibault fails to teach or suggest each feature of independent claim 19, as amended.

Furthermore, Applicants respectfully assert that dependent claims 20, 23, 26 and 32 are allowable at least because of their dependence from claim 19 and because they include additional features which are not taught or suggested by the prior art. Therefore, it is respectfully

submitted that claims 20, 23, 26 and 32 also distinguish over the prior art.

Regarding the rejection of independent claim 33, it is noted that claim 33 recites a method of manufacturing a lithium-sulfur battery comprising, amongst other novel features, providing an electrolyte comprising a sulfur-containing electrolyte salt and mixed organic solvents, wherein the mixed organic solvents of said electrolyte comprise at least three different solvents, each selected from a different group of a set of groups, the set of groups consisting of a weak polar solvent group, which is capable of dissolving elemental sulfur, a strong polar solvent group, which is capable of dissolving lithium polysulfide, and a lithium protection solvent group, which forms a good protective layer on a lithium surface; and wherein a volume ratio of the weak polar solvent to the strong polar solvent to the lithium protection solvent is 2:2:1.

As noted above, Thibault discloses a cell comprising a cathode, an anode and an electrolyte. Thibault however, fails to teach or suggest that it is preferable to include all three types of solvents in the electrolyte, such as a weak polar solvent, a strong polar solvent and a lithium protection solvent, as recited in independent claim 33.

Furthermore, Thibault fails to teach or suggest any volume ratio of the weak polar solvent to the strong polar solvent to the lithium protection solvent, and in particular that this volume ratio is 2:2:1, as recited in independent claim 33.

Accordingly, Applicants respectfully assert that the rejection of independent claim 33 under 35 U.S.C. § 102(e)/103(a) should be withdrawn because Thibault fails to teach or suggest each feature of independent claim 33, as amended.

Claims 19, 20, 23, 26 and 32 are rejected under 35 U.S.C. §102(e)/103(a) as being anticipated by, or alternatively unpatentable over Evans et al., (U.S. 4,302,520).

Applicants respectfully traverse this rejection for at least the following reason.

Regarding the rejection of independent claim 19, it is noted that claim 19 recites an electrolyte for use in a lithium-sulfur battery having electrode, the electrolyte comprising, amongst other novel features, a weak polar solvent, a strong polar solvent, and a lithium protection solvent, wherein a volume ratio of the weak polar solvent to the strong polar solvent to the lithium protection solvent is 3:1:1.

Evans discloses a non-aqueous cell utilizing an active metal anode, a cathode and a liquid organic electrolyte such as 3-methyl-2-oxazolidone in conjunction with a solvent and a selected solute (column 1, lines 7-14). The solvents used by Evans include tetrahydrofuran, methyl-substituted tetrahydrofuran, 1,3 dioxolane; **3-methyl-2-oxazolidone**; propylene carbonate and others (column 4, lines 28-35). Therefore, although Evans discloses strong and weak solvents, Evans fails to teach or suggest a strong polar solvent selected from the group consisting of hexamethyl phosphoric triamide, γ -butyrolactone, acetonitrile, ethylene carbonate, propylene carbonate, N-methyl pyrrolidone, sulfolane, dimethyl sulfate, ethylene glycol diacetate, dimethyl sulfite, and ethylene glycol sulfite, as recited in independent claim 19.

Furthermore Evans fails to teach or suggest a volume ratio of the solvents and in particular Evans fails to teach or suggest a volume ratio of the weak polar solvent to the strong polar solvent to the lithium protection solvent is 3:1:1, as recited in independent claim 19.

Accordingly, Applicants respectfully assert that the rejection of independent claim 19 under 35 U.S.C. § 102(e)/103(a) should be withdrawn because Evans fails to teach or suggest each feature of independent claim 19, as amended.

Furthermore, Applicants respectfully assert that dependent claims 20, 23, 26 and 32 are allowable at least because of their dependence from claim 19 and because they include additional features which are not taught or suggested by the prior art. Therefore, it is respectfully submitted that claims 20, 23, 26 and 32 also distinguish over the prior art.

REJECTIONS UNDER 35 U.S.C. §103:

Claims 19, 20, 23, 26 and 32 are rejected under 35 U.S.C. §103(a) as being unpatentable over Vourlis (U.S. Patent 5,432,030).

Applicants respectfully traverse this rejection for at least the following reasons.

Regarding the rejection of independent claim 19, it is noted that claim 19 recites an electrolyte for use in a lithium-sulfur battery having electrode, the electrolyte comprising, amongst other novel features, a weak polar solvent, a strong polar solvent, and a lithium protection solvent, wherein a volume ratio of the weak polar solvent to the strong polar solvent to the lithium protection solvent is 3:1:1.

Vourlis discloses an electrochemical cell employing an electrolyte comprising a mixture

of 3-methyl-2-oxazolidone in a range of 27 to 33 percent by volume and a volume ratio of 1,3-dioxolane to 1,2-dimethoxyethane (abstract). Vourlis fails to teach or suggest a strong polar solvent selected from the group consisting of hexamethyl phosphoric triamide, γ -butyrolactone, acetonitrile, ethylene carbonate, propylene carbonate, N-methyl pyrrolidone, sulfolane, dimethyl sulfate, ethylene glycol diacetate, dimethyl sulfite, and ethylene glycol sulfite, as recited in independent claim 19.

Furthermore, Vourlis fails to teach or suggest a volume ratio of the weak polar solvent to the strong polar solvent to the lithium protection solvent is 3:1:1, as recited in independent claim 19.

Accordingly, Applicants respectfully assert that the rejection of independent claim 19 under 35 U.S.C. § 103(a) should be withdrawn because Vourlis fails to teach or suggest each feature of independent claim 19, as amended.

Furthermore, Applicants respectfully assert that dependent claims 20, 23, 26 and 32 are allowable at least because of their dependence from claim 19 and because they include additional features which are not taught or suggested by the prior art. Therefore, it is respectfully submitted that claims 20, 23, 26 and 32 also distinguish over the prior art.

Claims 1, 4, 7-16, 33, 36 and 37 are rejected under 35 U.S.C. §103(a) as being unpatentable over Vourlis or Evans in view of Thibault.

Regarding the rejection of independent claim 1, it is noted that claim 1, as amended, recites a lithium sulfur battery comprising, amongst other novel features, a volume ratio of the weak polar solvent to the strong polar solvent to the lithium protection solvent being 3:1:1.

As noted above, neither Vourlis nor Evans nor Thibault, whether taken singly or combined teach or suggest a volume ratio of the solvents and in particular a volume ratio of the weak polar solvent to the strong polar solvent to the lithium protection solvent is 3:1:1, as recited in independent claim 1.

Accordingly, Applicants respectfully assert that the rejection of independent claim 1 under 35 U.S.C. § 103(a) should be withdrawn because neither Vourlis nor Evans nor Thibault fails to teach or suggest each feature of independent claim 1, as amended.

Furthermore, Applicants respectfully assert that dependent claims 4, 7-11 and 36 are

allowable at least because of their dependence from claim 1 and because they include additional features which are not taught or suggested by the prior art. Therefore, it is respectfully submitted that claims 4, 7-11 and 36 also distinguish over the prior art.

Regarding the rejection of independent claim 12, it is noted that claim 12 recites a lithium-sulfur battery comprising, amongst other novel features, wherein a volume ratio of the weak polar solvent to the strong polar solvent to the lithium protection solvent is 2:2:1.

As noted above, neither Vourlis nor Evans nor Thibault, whether taken singly or combined teach or suggest an electrolyte including mixed organic solvents wherein the mixed organic solvents include all three types of solvents. Furthermore, neither Vourlis nor Evans nor Thibault, whether taken singly or combined teach or suggest a volume ratio of the solvents and in particular a volume ratio of the weak polar solvent to the strong polar solvent to the lithium protection solvent is 2:2:1, as recited in independent claim 12.

Accordingly, Applicants respectfully assert that the rejection of independent claim 12 under 35 U.S.C. § 103(a) should be withdrawn because neither Vourlis nor Evans nor Thibault, fails to teach or suggest each feature of independent claim 12, as amended.

Furthermore, Applicants respectfully assert that dependent claims 13-16 and 37 are allowable at least because of their dependence from claim 12 and because they include additional features which are not taught or suggested by the prior art. Therefore, it is respectfully submitted that claims 13-16 and 37 also distinguish over the prior art.

Regarding the rejection of independent claim 33, it is noted that claim 33 recites a method of manufacturing a lithium-sulfur battery comprising, amongst other novel features, providing an electrolyte comprising a sulfur-containing electrolyte salt and mixed organic solvents, wherein the mixed organic solvents of said electrolyte comprise at least three different solvents, each selected from a different group of a set of groups, the set of groups consisting of a weak polar solvent group, which is capable of dissolving elemental sulfur, a strong polar solvent group, which is capable of dissolving lithium polysulfide, and a lithium protection solvent group, which forms a good protective layer on a lithium surface; and wherein a volume ratio of the weak polar solvent to the strong polar solvent to the lithium protection solvent is 2:2:1.

As noted above, neither Vourlis nor Evans nor Thibault, whether taken singly or combined teach or suggest an electrolyte including mixed organic solvents wherein the mixed organic solvents include all three types of solvents. Furthermore, neither Vourlis nor Evans nor

Thibault, whether taken singly or combined teach or suggest a volume ratio of the solvents and in particular a volume ratio of the weak polar solvent to the strong polar solvent to the lithium protection solvent is 2:2:1, as recited in independent claim 33.

Accordingly, Applicants respectfully assert that the rejection of independent claim 33 under 35 U.S.C. § 103(a) should be withdrawn because neither Vourlis nor Evans nor Thibault, whether taken singly or combined, teach or suggest each feature of independent claim 33, as amended.

CONCLUSION:

There being no further outstanding objections or rejections, it is submitted that the application is in condition for allowance. An early action to that effect is courteously solicited.

Finally, if there are any formal matters remaining after this response, the Examiner is requested to telephone the undersigned to attend to these matters.

If there are any additional fees associated with filing of this Amendment, please charge the same to our Deposit Account No. 503333.

Respectfully submitted,

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